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ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

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STANAG 4519 PPS (EDITION 1) - GAS GENERATORS, DESIGN SAFETY PRINCIPLES AND SAFETY AND SUITABILITY FOR SERVICE EVALUATION

Reference:
AC/310-D/149 dated 8 December 1998

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page iii is promulgated herewith.

2. The reference listed above is to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

4. National staffs are requested to examine page iii of the STANAG and, if they have not already done so, advise the Defence Support Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

for A. GRØNHEIM
Major General, NOAF
Chairman, MAS

Enclosure:
STANAG 4519 (Edition 1)

STANAG No. 4519
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

MILITARY AGENCY FOR STANDARDIZATION
(MAS)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: GAS GENERATORS, DESIGN SAFETY PRINCIPLES AND SAFETY AND SUITABILITY FOR SERVICE EVALUATION

Promulgated on 17 April 2000

for A. Vedrach

A. GRØNHEIM
Major General, NOAF
Chairman, MAS

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4 Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6 Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6)

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7 Page iii gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page iv (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/MAS - Bvd Leopold III - 1110 Brussels - BE

STANAG 4519
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARIZATION AGREEMENT
(STANAG)

GAS GENERATORS, DESIGN SAFETY PRINCIPLES AND SAFETY AND SUITABILITY FOR SERVICE EVALUATION

Annexes:

A. Design Safety Principles of Gas Generators.
B. Additional Design Safety Principles for Liquid Propellant Gas Generators
C. Design Safety Principles and Testing of Gas Generator Pressurised Structures.
D. Safety Tests of Gas Generators.
E. Environmental Tests of Gas Generators.

Related documents:

AEP-4	Nuclear Hardening Criteria for Armed Forces Materiel and Installations
AECP-1	Mechanical Environmental Conditions to which Materiel Intended for Use by NATO Forces could be Exposed.
AECTP-300	Climatic Environmental Tests.
AECTP-400	Mechanical Environmental Tests.
AOP-15	Guidance on the Assessment of the Safety and Suitability for Service of Munitions for NATO Armed Forces.
AOP-24	Electrostatic Discharge, Munition Assessment and Test Procedures.
AOP-25	Lightning, Munition Assessment Test Procedures.
AOP-34	Vibration Test Method and Severities for Munitions Carried in Tracked Vehicles
STANAG 1307	Maximum NATO Naval Operational Electromagnetic Environment Produced by Radio and Radar.
STANAG 2895	Extreme Climatic Conditions and Derived Conditions for Use in Defining Design/Test Criteria for NATO Forces' Materiel.
STANAG 4147	Chemical Compatibility of Ammunition Components with Explosives and Propellants (Non-Nuclear Applications).
STANAG 4170	Principles and Methodology for the Qualification of Explosives Materials for Military Use.
STANAG 4234	Electromagnetic Radiation (Radio Frequency) - 200 kHz to 40 GHz Environment - Affecting the Design of Materiel for Use by NATO Forces.

STANAG 4235	Electrostatic Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces.
STANAG 4236	Lightning Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces.
STANAG 4238	Munition Design Principles, Electrical/Electromagnetic Environments.
STANAG 4239	Electrostatic Discharge, Munition Test Procedures.
STANAG 4240	Liquid Fuel Fire Tests for Munitions.
STANAG 4241	Bullet Attack Test for Munitions.
STANAG 4324	Electromagnetic Radiation (Radio Frequency) Test Information to Determine the Safety and Suitability for Service of Electro-Explosive Devices and Associated Electronic Systems in Munitions and Weapon Systems..
STANAG 4327	Lightning, Munition Assessment and Test Procedures.
STANAG 4370	Environmental Testing.
STANAG 4375	Safety Drop, Munition Test Procedures.
STANAG 4382	Slow Heating Tests for Munitions.
STANAG 4396	Sympathetic Reaction, Munition Test Procedures.
STANAG 4416	Nuclear EMP Testing of, Munitions containing Electro-Explosive Devices.
STANAG 4439	Policy for Introduction, Assessment and Testing for Insensitive Munitions (MURAT)
STANAG 4518	Safe Disposal of Munitions, Design Principles and Requirements, and Safety Assessment.

AIM

1. The aim of this agreement is to establish the design safety principles and standardize the processes for analysis and testing to support the assessment of the safety and suitability for service of gas generators.

AGREEMENT

2. Participating nations agree that the documentation of gas generators designed and tested in accordance with the design safety principles and environmental and safety testing laid down in this STANAG, is valid for evaluation by NATO nations. Further, they agree that the results of the testing and analysis for the assessment of safety, and suitability for service carried out in accordance with this document will be provided by the developing nation to participating nations on request.

DEFINITIONS

3. a Gas generator. A gas generator is defined as a sub-system that generates gases to be used for a purpose other than providing thrust for direct rocket propulsion of the host munition. The gas generator comprises solid or liquid fuel and where applicable fuel tanks, combustion chamber, combustion controls, pressure release system, particle filter, initiation system, igniters and pipework to the application system.

b. Gas Actuator. A gas actuator is a special gas generator that generates a small amount of gas and converts it into a mechanical action using a piston.

Note This STANAG covers only the gas generator and the associated hardware to initiate it, sustain its operation and take its combustion products to the point of application. It does not cover the suitability of the hardware operated upon by the gases (e.g. turbine, hydraulic pump, hot gas servos, etc).

GENERAL

4. The design safety principles are produced as a guide for designers and as a check list for assessing authorities to use when assessing the basic suitability of a design and how well it meets its design requirement.

5. Annexes A, B and C document the design safety principles for gas generators and Annexes D and E document the safety and environmental tests required

6. The purpose of design safety analysis and environmental and safety testing is to provide the evidence for the assessment of gas generators, with their associated packaging where appropriate, to provide confidence that:

a. The gas generator as a whole and its components will remain safe and suitable for service and will function within specified performance limits throughout its service life This will include exposure to severe handling and extreme climatic conditions equivalent to those which may be found during storage, transportation and operation.

b. The risk of a safety failure or an unintentional explosive event occurring at any point throughout the service life is tolerably low. For example, hazards may arise during operation of the host munition, through a credible accident or an otherwise survivable enemy action.

c. There is no damaging interaction between the host munition, ship, vessel, fighting vehicle, platform, structure, aircraft or helicopter and the gas generator and/or associated packaging when subjected to service conditions.

d. The design, methods of operation and means of disposal of gas generators shall comply with relevant national Health and Safety and Environmental Protection legislation

e. The gas generators shall fail to a safe condition.

DETAILS OF THE AGREEMENT

7. Procedures. Each nation will be responsible for the evaluation of design and safety and suitability for service of gas generators to be used by its own Services and for this purpose will, as defined in AOP-15, require copies of the design characteristics, safety analyses and trial reports from the nation responsible for the development of the gas generator being evaluated. The nations carrying out the evaluation of design safety and safety and suitability for service of a particular gas generator shall agree to make their assessments, test parameters, safety analyses and trials reports available to other NATO nations intending to purchase, or to take over any munition using the gas generator. on request.

8. Variations on the Procedures

a. Notwithstanding the intention to avoid duplication of testing, each nation reserves the right to carry out additional testing and assessment if considered appropriate and, when necessary, to bear the financial costs of so doing.

b. Any significant changes proposed to the agreed evaluation procedures will be provided to the user nation for comment and concurrence.

c. The service environment to which the munition containing the gas generator may be subjected will be specified by the user nation. The specific test programme need not be limited to tests described in this document. The selection of tests, test parameters and test sequences shall be based on design safety assessment including hazard analysis and the measured, or analytically forecast, environmental life cycle profile of the gas generator item, as indicated in AOP-15, to optimize detection possibilities of any failures.

SAFETY TESTING OF EXPLOSIVES USED IN GAS GENERATORS

9. The safety characteristics of the explosives or propellants selected for use in gas generators shall be established in accordance with STANAG 4170 or national requirements, whichever is more severe. The compatibility of all materials shall also be assessed in accordance with STANAG 4147

DESIGN SAFETY ASSESSMENT

10. The gas generator shall be assessed against the design safety principles specified in Annexes A to C of this STANAG, as appropriate, and as further amplified by the developing nation if required. Formal hazard analysis methods may need to be used. This design safety assessment identifies the required safety tests and may highlight the need to examine in more detail some particular features or perceived weaknesses of the design.

LIFE CYCLE

11. During a manufacture-to-target or disposal sequence (MTDS), gas generators fitted in their munitions or carried separately, may encounter ground, sea and air environmental conditions. Within these environments, the gas generator may be subjected to storage, handling, testing, transportation by road, rail, sea and air, carriage in ships, fighting vehicles and aircraft, loading, firing and in-flight forces. The tests required to establish the safety and suitability for service characteristics of the gas generator shall take account of the need to demonstrate the effects of the expected environment on the gas generator during its expected life cycle in accordance with the Operational Requirement.

ENVIRONMENTAL SPECIFICATION

12. To ensure that the environments used during tests are representative, the anticipated environment shall be consistent with the Operational Requirement and the design specification for the host munition, i.e. certification that the anticipated environment has been correctly defined needs to be given by the appropriate Operational Requirements office of the developing nation's Service or Services. This process is defined in AOP-15.

ENVIRONMENTS

13. Environments which shall be considered for the assessment and testing of gas generators should be selected using the questionnaire at Annex A to AOP-15 and are summarised as:

a. Climatic environments: temperature, pressure, humidity, sand, lightning or salt spray.

b. Mechanical environments associated with the handling and transportation of gas generators from manufacture, through storage and fitting to host munition, to loading into deep or ready use magazines or stowages in a ship, vessel, aircraft, fighting vehicle, or military installation.

c. Electrical environments including induced electromagnetic, electrostatic and nuclear environments.

d. Abnormal environments associated with enemy action and accidents. eg. fire, strike by other ordnance or fragments, aircraft crash, handling accidents, etc..

e. Induced environments associated with the possible final disposal of the gas generators.

OUTLINE OF SAFETY AND SUITABILITY TEST PROGRAMME

14. The safety and suitability test programme shall be developed for gas generators based on design safety assessment, hazard analysis and the environmental profile as indicated in Paragraphs 7 to 13 above. Such a programme will include both safety and suitability tests, as described in Paragraph 15 below, and the construction of the test programme will include the sequencing of tests to represent the MTDS. The selection of tests, test methods, parameters, duration and sequence shall be agreed with the Project Manager or delegated representative and the logic of these choices related to the specified environment shall be documented.

SAFETY AND SUITABILITY TESTS AND ASSESSMENTS

15. The safety tests and assessments, given at Annex D, are those which shall be conducted to establish adequate safety during operation of the host munition, in credible accident situations and to demonstrate suitability for service. The applicability of some of these tests is conditional upon the design of the particular host munition and its intended use. Suitability tests and assessments, given at Annex E, are used to provide further evidence to assess safety and suitability for service to survive a given environment within the specification. All common or specific suitability tests and assessments shall be considered when developing a safety and suitability test programme for a gas generator.

ADDITIONAL TESTS

16. Further tests, not included in Annex E, may be conducted if considered necessary by the developing authority. In particular, the effect of damage to or unintentional operation of the gas generator on the host munition or its transporting system may require further tests to be undertaken. Any test intended to assess the response of the gas generator to a particular environment or hazard is to be conducted to satisfactorily simulate that environment or hazard.

TEST PARAMETERS

17. Standard test procedures and test parameters are given in Annexes D and E. Test severities shall be at least in accordance with the minimum requirements presented in or referred to in these Annexes. If the results of analyses lead to more severe testing, or tests not mentioned in these Annexes, the appropriate severities or tests shall be included in the test programme. Nothing in this STANAG should prevent a nation deciding on a higher or more severe criterion if it so wishes. However, the developing nation should be consulted in the event that a more severe test is specified in case the test is outside the specified design parameters of the gas generator.

TEST PROCEDURES

18. The tests described in Annexes D and E shall be conducted in accordance with promulgated test STANAGs. In those instances where appropriate STANAGs have not yet been approved, national procedures will apply until promulgated by ratified STANAGs. Items within the host munition may be substituted by non-functional items provided this does not detract from the purpose of the test or the test sequence. Such configurations must be specified in the test plan and reported in the test report.

CHOICE OF TEST AND TEST SEQUENCE

19 Some of the safety and suitability tests within the programme are conducted sequentially to verify that the gas generator will be safe and suitable for service in the expected environments. Some will be as part of the environmental testing of the host munition. Such sequences may end with destructive functioning, destructive safety tests or destructive detailed examination. Gas generators may be withdrawn at various points for detailed examination to ascertain the effects of specific environments. The detailed design of the gas generator should be critically examined so that the sequence or sequences represent the best compromise between a realistic MTDS and those sequences which will cumulatively produce the most severe degradation of the gas generators under test. The content of test sequences and the number of gas generators involved will also be influenced by any similarities with previous designs or by technical innovation in the design. However, differences in host equipments may result in very different MTDS between two almost identical units.

RESULTS OF TESTS AND ASSESSMENTS

20. Reports of tests and assessments shall be made available by the developing nation to participating nations on request. Where there is evidence of unacceptable or unsatisfactory results, the significance of these shall be explained by the developing nation.

RELATIONSHIP WITH DEVELOPMENT TESTING

21. The results of development trials carried out with gas generators or components representative of the production build standard may be taken into consideration in the evaluation of safety and suitability for service, providing test data are made available.

REPORTS ON SAFETY AND SUITABILITY TESTS AND ASSESSMENTS

22. It is essential that adequate data is made available to National/Service safety evaluation organisations for the evaluation of gas generator safety and suitability for service. Therefore nations developing the host munition shall compile a data package which documents the test methods and rationale for the programme selection. Reports should be from accredited test ranges/authorities and carry a satisfactory assurance of quality. The package will also give the detailed results obtained during safety and suitability tests. Where results from development trials have been used to permit fewer units in the sequence or to reduce the duration of environmental tests, then the results of these development trials should also be included. This data package shall be supplemented by a technical design data package.

IMPLEMENTATION OF THE AGREEMENT

23. This STANAG is implemented by a nation when that nation has issued instructions that all gas generators procured for Service use will be designed, assessed and tested in accordance with the principles and procedures detailed in this agreement.

DESIGN SAFETY PRINCIPLES OF GAS GENERATORS

GENERAL REQUIREMENTS

1. The system and all component parts of the system shall be designed and installed in such a manner as to:

   a. Function correctly in accordance with the appropriate specification or technical requirement. In particular any component whose function may be impaired by incorrect installation shall be designed so that only correct orientation is possible.

   b. Remain safe and suitable for service when subjected to the climatic and mechanical conditions of storage, handling, transportation, test and operation as laid down in the weapon Environmental Design Specification.

   c. Meet the appropriate safety requirements of Annex C.

   d. Prevent unacceptable damage to any component part of the system or associated munition by any discharge, leakage or heat transfer.

   e. Remain safe and suitable for service when subjected to the electrical environment described in STANAGS 1307, 4234, 4235 and 4236.

2. All initiation and control systems shall be designed and demonstrated to operate to design requirements and to provide the required response and performance over the service life and environment specified for the weapon.

3. Protective finishes shall be applied, where appropriate, to minimise deterioration of the system and its components during their life in the specified environmental conditions.

4. Where pressure sensors and telemetry transducers are a permanent feature of the system their functioning or failure shall in no way impair the functioning of the system.

5. The construction of connectors for ignition, control and measurement systems shall be such that wrong connections are impossible.

DESIGN CRITERIA

6 For hot gas power systems intended to be initiated in addition to, or at a time other than when a host munition is in free flight, the system shall either shut down when the limit pressure is reached or, in the event of the normal gas outlet passages becoming obstructed, vent gas safely through an orifice designed for the purpose. Any vented gases shall not constitute a hazard to the launcher, launch platform or personnel ***especially with regard to the toxicity and burning of vented gases***. Once the gas pressure has returned to the nominal value the orifice shall close to preserve the normal working pressure.

7 A single component failure shall not impair the "fail-safe" characteristic above. In the event of a double fault, the unit should safely contain the generated gases under their maximum pressure using the factors in Table 1 of Annex C, or should fail in such a way that no major fracture occurs which would endanger other equipment, personnel or result in risk of fire.

8. Some propellants and igniter materials are susceptible to moisture. Adequate sealing at high temperature and humidity shall be demonstrated.

SAFETY REQUIREMENTS

9. Each system and all component parts of the system shall be designed and installed to:

a. Comply with the appropriate safety requirements of Annex C.

b. Remain safe when subjected to the accident situations laid down in the weapon specification.

c. Satisfy, as determined by the host munition, the safety tests of STANAGS 4240, 4241, 4375 and 4382.

10. The electrical features of the igniter and its circuits shall meet national requirements until superseded by a ratified STANAG.

11. Where a system is incorporated in a munition other than as a complete tested entity, the procedures and sequence of assembly and test shall be defined to ensure safety and reliability.

12. Where a munition is attached to an aircraft, ship or vehicle, the provisions of the appropriate safety requirements for the carrier shall be taken into account.

13. Compressed air shall not be used for purging or testing any part of a system which is in contact with propellants. A dry inert gas such as nitrogen or argon shall be used

STRENGTH AND LIFE REQUIREMENTS

14. The proof and ultimate design conditions shall be established in accordance with the requirements of Annex C. The unfactored limit pressure shall encompass the most adverse environmental, operational and other weapon system specification requirements.

15. Demonstration of compliance with the proof and ultimate design requirements shall be by calculation and/or tests as required by Annex C. Compliance shall be realisable at any time during and up to the specified life of the part.

16. Each part of the system shall be designed to operate within its design requirements over the service life of the munition or the gas generator whichever is the shorter.

17. Particular attention shall be paid to the effect of certain additional environmental conditions, such as moisture, microbiological agents and ultraviolet light during the design of composite (non-metallic) components. Where necessary a gas generator, or appropriate parts of it, shall be subjected to a programme of appropriate environmental tests.

18. The sub-system shall also withstand:

a. Any bending or torsion loads which may occur during storage, transport, launch, flight or separation.

b. The strains which arise from shear, torsion and bending under rocket thrust and external loading conditions

TEST REQUIREMENTS

19. Unless otherwise specified in the relevant paragraph in this Annex, design confirmation tests other than structural tests shall be carried out on the complete sub-system and on its component parts in accordance with national standards. Tests shall be carried out as required to support safety and environmental assessments in accordance with Annexes D and E.

20. A test programme shall be arranged to demonstrate the performance within design requirements over the full environmental specification, including high and low temperatures, vibration and service life.

21. All pressurised items and structures shall be subject to structural testing as required by Annex C.

22. Tests shall be made to demonstrate compliance with national electrical bonding and safety requirements and STANAG 4238 when ratified.

23. If the propellant charge is a solid it shall be inspected by suitable methods to detect flaws and cavities to a level to be defined by the Design Authority.

24. The inhibition of the propellant charge shall be tested by suitable methods (for example peel, thermal bonding and shock tests) to detect lack of adhesion to a level to be defined by the developing nation.

25. All materials in contact with propellants shall have been demonstrated to be compatible with the propellant in accordance with STANAG 4147

IGNITION REQUIREMENTS

26. The ignition system shall be designed in conjunction with the rest of the system such that the propellant is ignited reliably and in a reproducible manner for all design conditions.

27. The ignition system shall function adequately at low temperatures and without causing excessive pressure peaks at high temperatures. In certain cases, such as those of airborne or underwater weapons, the igniter shall also operate effectively throughout the ranges and combinations of internal and external environmental pressure specified.

GAS GENERATOR CHARGE REQUIREMENTS

28. The solid propellant charge shall have adequate capacity to fulfil its required function for the stipulated time and to meet its operational programme under the specified environmental conditions.

29. The geometric design, composition and nature of the propellant, taken in conjunction, shall be such that during the required life of the charge it will not crack or deform to an extent that will significantly affect its performance under the influence of thermal stresses produced by changes in ambient temperature.

INHIBITION REQUIREMENTS

30. Where inhibition of part of the burning surface of the charge is required materials used shall have adequate thickness, strength of adhesion and resistance to erosive gas flow. These properties shall not be unacceptably impaired during storage or carriage of the propellant charge under the specified environmental conditions.

31. The nature of the inhibiting material shall be such that during storage of the system, any migration of ingredients into the propellant or ingredients of the propellant into the inhibiting material shall not significantly change the effectiveness of either.

MECHANICAL REQUIREMENTS

32. The gas generator shall be sealed to prevent the ingress of moisture, since the presence of moisture on the surface of the propellant charge would affect its ignitability and may cause degradation of the propellant. If the method of sealing is required to break up or disperse on ignition, then it must do so in a manner so as not to affect performance or create a hazard to the weapon system, launch vehicle ***or personnel***.

33. The system shall be designed so that all gases which could damage the interior of the weapon system or its equipment are exhausted outside the weapon system. Any exhaust seal used shall not cause a hazard to a host munition, surrounding structure or personnel when ejected.

34. Any part of the system that would be adversely affected by solid particles produced by the initiation system, propellant or inhibition shall be adequately protected by filters or other devices.

35. If a gas pressure relief valve is fitted in the system, the pressure at the maximum possible flow shall be taken into account when designing or choosing the valve. Where the pressure rise is likely to be rapid the transient response of the valve shall be considered. Any significant differential pressure (hysteresis) between the opening and closing pressure/flow characteristics shall also be considered.

36. If an external burster disc is fitted to the system, it shall be protected from damage due to igniter sparks or debris.

37. The system shall be designed to operate safely within the defined environment and provide gas pressure and flow throughout the specified life.

ADDITIONAL DESIGN SAFETY PRINCIPLES FOR LIQUID PROPELLANT GAS GENERATORS

DESIGN REQUIREMENTS

GENERAL

1. Marking of components of liquid propellant systems shall be in accordance with national standards except where this Annex requires otherwise.

2. The arrangement of the liquid propellant system in the weapon shall be such that it is not exposed to heat which could cause unacceptable deterioration of the liquids, change in performance or introduce a safety risk to the system. Thermal insulation may thus need to be provided to prevent unacceptable heat transfer.

3. Cleanliness conditions shall be specified and chemical contamination avoided during the manufacture and filling of pressurised gas or propellant tanks, and during the manufacture, assembly and test of the system components. Any part of the system that could be adversely affected by the presence of foreign matter during operation shall, if appropriate, be protected by filters or other devices.

4. All requirements of the developing nation concerning the toxicity of the liquids and products of decomposition or combustion shall be taken into account.

PROPELLANT TANK REQUIREMENTS

5. The propellant tanks are pressure vessels and shall be designed to meet the requirements of Annex C, with consideration being given to:

    a. The chemical stability of the propellant. The primary requirement is that the materials of construction shall be compatible with the contained propellant for the required period, under the specified environmental conditions.

    b. Any chemical action by the propellant on the tank material.

6. Ullage shall be provided in a propellant tank to allow thermal expansion and/or decomposition of the propellant. The injection of the subsequent pressurised gas bubble into the propellant feed system shall not cause an unacceptable malfunction of the hot gas system.

7. Where the temperature specified in the environmental specification for the system allows freezing of the propellant in storage, this shall not be allowed to affect the subsequent safe, reliable storage or operation of the tanks.

8. Where, due to decomposition of the propellant, the required storage life of the system is greater than can be achieved by one filled life , means shall be provided to overcome this by one of the following methods:

    a. Draining, and where necessary cleaning, and refilling.
    b. Replacement of the tank.

9. Where instruments such as pressure gauges and telemetry transducers are fitted to systems for monitoring purposes, the failure of the instrumentation shall not impair the functioning of the system. Additionally, where pressure gauges are fitted, the function/accuracy of the gauge is to be assured.

10. All pipe couplings, connectors and other fixings shall be positively locked in accordance with national standards. In bipropellant systems all pipe couplings, connectors and other fittings shall be such that cross connection of the two constituents cannot be made.

11. National standards shall be applied to the electrical bonding requirements of the assembled propulsion system and to tanks containing flammable propellant when handled separately.

12. Where a system is to be fired more than once for test purposes connectors shall be provided in the pressurising gas and propellant supply systems so that the system can be completely drained and vented after each run. The design of the system shall also allow the appropriate sections of the propellant pipes to be fully primed and all trapped gas to be removed.

PRESSURISATION SYSTEM REQUIREMENTS

13. Direct pressurisation or free surface expulsion occurs where the pressurising gas is in direct contact with the propellant. This method of expulsion is only suitable for certain gravity environments and baffles are usually necessary to prevent ingestion of pressurising gas into the propellant feed system. Tanks may be fitted with capillary surface tension devices in low gravity environments to ensure gas-free propellant at the tank outlet. However, these devices have a large surface area which could produce a high decomposition rate in some propellants.

14. Positive expulsion systems where the pressurising gas is not in direct contact with the propellants will usually be applicable to weapon systems. In this type of tank system propellants can be expelled in almost any orientation or gravity environment.

15. Pressurisation of an internal bladder or diaphragm provides

a. Two fault safety through double containment of the propellant.

b. Separation of the propellant from the pressurising gas during operation of the system.

16. If the propellant tanks are pressurised by a stored gas system there shall be a means of isolating the propellant system from the gas supply to provide a positive separation until the normal operation of the propulsion system.

17. The vessel for storing the gas shall be designed in accordance with the requirements of Annex C.

18. If the propellant tanks are pressurised by a hot gas or any system energised at the time of operation, they shall be designed in accordance with the requirements of Annex A or this Annex as appropriate to the type of propellant used.

19. If bipropellant systems are filled in situ, the tank design shall be such that the filling connections cannot be interchanged. The method of filling shall be such that no spillage of the propellant is possible during the operation. When filling is completed the filling ports shall be sealed and marked in accordance with national standards.

20. The liquid propellant system shall be designed so that in the event of damage to a propellant tank, the tank can be removed safely or its contents withdrawn in a safe manner without jeopardising the safety of the rest of the system and weapon.

PROPELLANT SUPPLY SYSTEM REQUIREMENTS

21. The propellant supply pipework shall meet the relevant requirements of this Annex.

22. Particular care shall be taken to ensure the compatibility of any sealing materials and seals with the propellants for the specified life of the motor or, for seals exposed only during operation, for a period at least ten times the maximum exposure time.

23. In bipropellant systems, propellants shall only be able to mix inadvertently after at least 2 failures of an independent nature have occurred.

24. Slow decomposition of the bulk propellants may occur during the life of a filled tank. Calculations supported by a long term storage trial representing the environmental life shall be carried out to establish that the ullage pressure does not exceed the maximum storage pressure of the tank at any time during its life. If tanks are fitted with bursting devices, reference should be made to the requirement for burster discs given below. For propellants with a significant decomposition rate, for example hydrazine, a suitable production test may be required to determine the rate of pressure rise in each tank. Alternatively, pressure monitoring of the tank is acceptable at levels below the maximum storage pressure provided that remedial action can be taken to prevent the ullage pressure level reaching the tank maximum storage pressure.

25. The compatibility of the pressurising gas and the propellants shall be demonstrated for a period of at least that of the operational life of the gas generator.

26. When burster discs are fitted they shall be designed to have a rupture pressure, when pressurised from the propellant side, of at least twice the maximum predicted tank pressure at the end of the stored life of a filled tank. This tank pressure should be that at the maximum specified temperature including normal emergency temperature excursions as specified by the developing nation.

27. Where a system is required to shut down and repressurise at a later time, this shall be done in such a way that all parts of the system perform in a safe manner and that all pressures remain within specification.

28. Individual earth leads are not essential provided that each component part of the system is electrically bonded to earth through its mechanical coupling.

PROPELLANTS AND IGNITION REQUIREMENTS

29. The ignition system shall be designed in conjunction with the rest of the system such that the propellant is ignited reliably and in a reproducible manner and will stay ignited for the required duration for all design conditions.

30. Special attention shall be given to the sealing of the igniter since absorption of moisture may seriously affect its functioning.

31. An igniter giving gaseous rather than particulate products is preferred to reduce contamination.

TEST REQUIREMENTS

32. Liquid propellant systems shall be proved and tested to the test requirements of Annex C.

DESIGN SAFETY PRINCIPLES AND TESTING OF GAS GENERATOR PRESSURISED STRUCTURES

INTRODUCTION

1. The requirements of this Annex are in addition to any statutory requirements or regulations applicable to pressure vessels or pressurised structures or systems.

2. This Annex primarily relates to structural performance and behaviour under differential pressures.

3. Numerous pressurised parts store pressure energy or hazardous substances, frequently for long periods of time. These parts include "one shot devices" which experience a single pressurisation only. Failure of such parts can introduce particular risks, and the greatest attention must be paid to safety at all times.

SCOPE AND GENERAL REQUIREMENTS

4. Pressurised parts can be subject to a wide spectrum of loads and operating requirements. Design factors shall be applied appropriate to each design, part and application.

5. For all pressurised parts, the compliance with structural strength, stiffness and fatigue life requirements shall include freedom from unacceptable leakage, discharge or ingress of pressurising gas or liquid.

STRUCTURAL DESIGN FACTORS

6. All pressure loadings and factors shall be related to limit pressure(s) established by the developing nation in accordance with this Annex.

7. The minimum structural design factors for proof and ultimate conditions for different applications, categories and uses are given in Table 1 of this Annex.

8. The minimum structural design factors of Table 1 shall not be taken to cover effects such as fatigue, cumulative damage or structural degradation.

9. The primary application categories in Table 1 relate directly to the type of use and phase(s) of operation when subject to pressure.

10. Where a pressurised part can be subject separately or simultaneously to pressure loadings and to loadings from other causes such as operational, flight or acceleration loads, appropriate design factors shall be applied to each loading. The design shall meet the most adverse combinations of factored loads that can arise.

11. Where an abnormal limit pressure is declared (see later), this may be associated with reduced factors of 1.25 ultimate and 1.0 proof where failure cannot cause a hazard to personnel.

LIMIT PRESSURE

12. Limit pressure is the pressure to which all designs are related. It is defined as the greatest pressure attainable or experienced by the part under the most adverse conditions within the limits and conditions specified for the equipment, system and application, and at any time in its life from manufacture to final use. Either an absolute or a statistically determined value may be used, as appropriate. Limit pressure shall be established and declared by the developing nation.

13. Attention shall be given to and allowance made for all conditions that can influence pressure. These include but are not limited to operational, test, material, age and sample to sample conditions and variables. Consideration shall include dynamic conditions including transient pressure peaks.

14. For parts and systems positively controlled to a regulated or working pressure, or where pressure is limited by valves, burster discs or similar devices, limit pressure shall be established in relation to the most adverse design setting or operating pressures or tolerances, with due allowance for adverse pressure effects due to flow constraints. In the absence of substantive data for a lower value, limit pressure shall be 1.25 times the controlled pressure. Consideration shall be given to the need for a higher value in critical applications.

15. Where limit pressure is derived statistically, or is determined from or substantiated by tests, it shall be the pressure which has a 1x10-3 probability of occurrence with 95% confidence under the most adverse design conditions. For particular applications, different statistics may be proposed by the developing nation and shall be agreed by the project manager.

16. For certain parts and/or applications it may be necessary to consider exceptional individual malfunction, failure, abnormal condition or overload cases. The pressure under such conditions may be specified as an abnormal limit pressure.

STATIC STRENGTH VALIDATION

17. The strength and stiffness of all designs shall be substantiated in accordance with national standards for each application. Adequate use shall be made of tests to confirm and support calculations for all parts.

18. Strength of parts shall normally be substantiated by ultimate strength tests. Exceptions are permitted as further detailed below.

19. For parts where failure cannot cause a hazard to personnel, and where design and manufacture are conventional and use metallic materials it is permissible to substantiate strength by a production strength test on every example before use. To employ this procedure each example shall be pressure tested to a value at least equal to limit pressure times the proof design factor.

20. Very exceptionally where testing as described above is not feasible, substantiation may be permitted using calculations alone. For each design and application the developing nation shall define and enforce appropriate strict controls and tests during manufacture to confirm and maintain structural standards and integrity

21. For first substantiation or for any re-validation of a design by tests, the test results shall be subject to the assessment requirements of Paragraph 24. Where a part shows alternative modes of failure under the same test conditions, the test results may be combined where the alternatives can be shown to be of comparable probability in terms of, for example, stresses or reserve factors.

22. For parts validated by ultimate strength tests, where there is a significant change in detail design, material, manufacturing source or technique, or where no examples have been completed over a period of twelve months or more, strength shall be re-validated by the procedure used initially.

23. The requirements for a successful test are:

a. During the application and after removal of loads up to the factored or corrected proof load, the element or structure shall not sustain deformation detrimental to the functioning of the weapon system. After removal of the loads all relevant interchangeability requirements specified for the gas generator or its components on the appropriate drawings shall be maintained.

b. The element or structure shall not fail before the factored or corrected ultimate load is reached.

c. For strength substantiation and analysis purposes parts that fail under test shall be deemed to have failed at the highest pressure sustained.

24. Parts may be tested as complete or part assemblies. They shall be supported and loaded in a manner representative for all elements. Where significant to the design, effects such as fluid flow and dynamic characteristics shall be simulated by the best practicable manner. Pressurisation rate shall be selected as far as practicable so as not to influence failure mode or enhance test results.

25. Where a part can be subject simultaneously to non pressure-related loads, these shall be simulated (with appropriate factors) unless shown not to be significant to strength under pressure loads.

26. Temperature, environmental and other design parameters for the application shall be considered prior to test. Where testing under adverse values of such variables could adversely affect strength or behaviour, such parameters shall be incorporated in the test or due allowance made. Particular care shall be taken to represent adequately the effects of elevated temperature.

27. The requirement for thermal soak or other conditioning prior to test shall be considered and applied where it could adversely affect test results.

28. Where a part is subject to fatigue type loading, whether pressure related or not, substantiating strength tests shall demonstrate compliance after loading equivalent to the declared safe life, that is the life at which static strength is not to be impaired.

29. Due account shall be taken of erosion of internal gas ways and any attendant strength reduction. This is especially important for multiple shot devices.

FATIGUE STRENGTH VALIDATION

30. When testing to a single pressure level cycle, the upper test pressure shall be limit pressure unless an alternative value is appropriate. For actual cycle testing, pressures shall not be less than those that can arise under the most adverse conditions. Accelerated testing is permitted only where the ratio of stress levels can positively be related to cycles to failure.

31. In certain circumstances, where the declared safe life is less than the life requirement, an extension of life beyond the initial declared value is permissible, subject to satisfactory results from defined periodic inspections, commencing at the declared safe life. To permit this approach, it shall be demonstrated that the minimum defect that can be readily and reliably detected by that inspection cannot develop to failure over a period which is less than of the declared inspection period. The factor by which the time for the defect to progress to failure is to exceed the inspection period shall be dependent on application and test data. Full details of inspection periods and standards shall be provided on the part or in the appropriate schedule, and referenced on drawings.

32. All testing shall be undertaken using practices and procedures comparable to those for static structural strength validation testing.

STRUCTURAL DESIGN FACTORS

CATEGORY WHEN PRESSURISED	MINIMUM DESIGN FACTOR	
	PROOF	ULTIMATE
Prior to and during launch,release or ejection.	1.25	1.50
In "flight", away from launcher, launch vehicle or personnel.	1.125	1.33
Parts whose failure could be a hazard to personnel.	1.25	1.50
Parts subject to high risk.	1.25	2.0 or more.
"One shot" devices meeting special control criteria prior to launch.	1.125	1.33
"One shot" devices meeting special control criteria away from launcher.	1.125	1.25

TABLE 1.

SAFETY TESTS FOR GAS GENERATORS

NOTE Many of these tests will be carried out with the gas generator fitted in situ in the host munition as part of the tests on the host munition. In order to gain complete confidence it may be necessary to test more samples, usually as sub-systems. **The precise nature of the test schedules will depend on the operational environment of the gas generator**.

1. Strength of Design

a. Reason for Test This test is conducted to demonstrate the strength of design of the gas generator pressurised components.

b. Information Gas generators are to be loaded with special or overpressure charges, or the pressure relief valve is to be set to work at the test pressure.

c. Test Procedure Test in accordance with national standards.

2. Propellant Safety

a. Reason For Test This test is conducted to verify that the Maximum Operating Pressure (MOP) generated by the propellant charge is lower than the gas generator Safe Maximum Pressure for a specified worst case operating condition.

b. Information Propellant charges shall be subjected to preliminary environmental stressing. Propellant that has been subjected to sequential environmental tests may be used for this purpose. The propellant is to be fired at the temperature giving rise to the maximum chamber pressure, in order to record the extreme service pressure. This will normally occur at the maximum firing temperature. Additional firings may be required at other extremes of temperature to determine the temperature at which extreme service conditions apply.

c. Test Procedure Tests are to be fired, normally, using a sample of 4 gas generators, using no fewer than 2 propellant lots. ***The sample size may be varied depending on the type and use of the gas generator***. Pressure, ignition delay and time for which specified output pressure is produced are to be recorded for each shot

3. Safety Drop

a. Reason For Test. This test is conducted to determine the reaction of the gas generator to impact and whether it is safe to handle and dispose of by qualified personnel following impact from high accidental drops.

b. Information. This test simulates an accidental drop of the gas generator fitted in its host munition during loading (or unloading) for transport or use. The minimum height for this test is to be 12 m.

c. Test Procedure. This test is carried out as part of the host munition tests and should be conducted in accordance with STANAG 4375. If study of the MTDS indicates that the height of drop may exceed 12 m for any known class of ship or vessel, after full allowance for clear lifting height and safety margins, then the test should be carried out at the greatest height assessed.

4. Liquid Fuel Fire

a. Reason For Test This test is conducted to determine the reaction of the gas generator, when fitted to a host munition, to an intense fire (eg. aircraft/ helicopter/ vehicle crash).

b. Information The quantity of fuel should be chosen to ensure that the duration of the fire is sufficient to cause reaction of the host munition. The severity and time to the reaction will be assessed. In most cases, the test criteria will require that the host munition does not detonate, or become propulsive during the test, and/or react within a given time. The host munition may be packaged and/or unpackaged depending on the MTDS sequence.

c. Test Procedure The test shall be conducted in accordance with STANAG 4240.

5. Slow Heating

a. Reason For Test This test is conducted to determine the reaction of the gas generator to increasing heat over a long period such as may result from a fire in an adjacent building or compartment.

b. Information The temperature of the gas generator is raised gradually until a reaction occurs (or 310C is reached). The reaction of the gas generator may be more severe than that observed during the Liquid Fuel Fire Test because the structure of the munition may provide containment for the explosives until a higher temperature is reached, or the explosive components may react differently to slow heating regimes.

c. Test Procedure The test shall be conducted in accordance with STANAG 4382.

6. Bullet/Fragment Attack

a. Reason For Test This test is conducted to determine the reaction of the gas generator to bullet attack and fragment strike.

b. Information The test criteria shall specify the acceptable reaction of the gas generator. It should not detonate, explode or become propulsive when struck by the specified test bullet types. A variety of bullet types may be specified, both to assess reaction to direct impact as a result of enemy/terrorist attack and to simulate fragments produced by detonation of warheads. Any residue should remain safe for handling and disposal. Prior to this test, the gas generator may be subjected to an environmental conditioning sequence. Unless the gas generator is large or likely to have a highly energetic reaction this test may be considered to be inappropriate.

c. Test Procedure The test shall be conducted in accordance with STANAG 4241. Additional fragment attack tests to national procedures may also be used.

7. Toxic Contaminants

a. Reason For Test This test is conducted to determine whether any toxic products of combustion of the gas generator could be a hazard to adjacent personnel.

b. Information To be carried out in a sealed container after completion of environmental tests. Samples to be collected and results to be assessed against national standards.

c. Test Procedure The test shall be conducted in accordance with national procedures.

ENVIRONMENTAL TESTS FOR GAS GENERATORS

NOTE 1 Many of these tests will be carried out with the gas generator fitted in situ on the host equipment as part of the tests of the host equipment. In order to gain complete confidence it may be necessary to test more samples, usually as sub-systems.

NOTE 2 The sequence of tests in this Annex is loosely based on a possible MTDS.

1. Logistic Vibration

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following transportation by sea, road, rail and air.

b. Information The real environment is a mixture of random and sinusoidal vibration. Sinusoidal vibration at specific low frequencies is dominant in transportation by ship, whereas random vibration is more significant in road and rail transport. Air transportation vibration is mainly random in nature but may have specific peak sine vibration at discrete frequencies, particularly in helicopters and propeller driven aircraft. The type of vibration testing selected must be chosen from the principal transportation modes in the manufacture to target or disposal sequence (MTDS). It may be necessary to carry out the selected vibration tests at appropriate high and/or low temperatures associated with transport modes.

c. Test Procedure Tests shall be conducted in accordance with AECTP-400 - Method 401, or national procedures.

2. Loose Cargo

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following repetitive shock loadings expected during transportation and/or handling.

b Information Repetitive shocks may arise from road or rail transportation, or by handling in mechanical systems and roller conveyors.

c. Test Procedure Tests shall be conducted in accordance with national procedures until AECTP-400 - Method 406 is implemented.

3. Shock - Non Repetitive

a. Reason For Test The test is conducted to demonstrate that the gas generator will remain safe and serviceable following non repetitive shocks, multiple small drops or transient vibration expected during transport, handling and operation.

b. Information Shock, multiple small drops, transient vibration or horizontal impact may occur during transportation by road, rail or air, in mechanical handling systems, or during crane operations. They may arise by design during use (eg catapult launch/arrested landing). The severity should be chosen to be representative of the worst case likely to be encountered during the MTDS.

c. Test Procedure The test shall be conducted in accordance with AECTP-400 - Method 403, or national procedures.

4. High Temperature Cycling

a Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable after storage in temperate, hot humid or hot dry conditions.

b. Information The test may also be used to represent accelerated ageing. The test cycles will normally be selected from those specified in STANAG 2895. Each cycle will represent a 24 hour period. The cycles may be conducted with low humidity conditions, with controlled high humidity conditions, or with the effects of high solar radiation superimposed. Such cycles may be used to represent accelerated ageing where an assessment of the store design indicates that high temperature cycling will cause appropriate deterioration. The selection of the cycles to be used, and the number of cycles to be applied, will depend upon assessment of the worst case in-service logistics of the store and the amount of accelerated ageing to be represented. Account should be taken of any environmental protection (eg by container design) provided for the store.

c. Test Procedure The test shall be conducted in accordance with AECTP-300 - Method 302.

5. Low Temperature Cycling

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable after storage in cold conditions.

b. Information The test cycles will normally be selected from those specified in STANAG 2895. Such cycles may be used to represent accelerated ageing where an assessment of the store design indicates that low temperature cycling will cause appropriate deterioration. The selection of the cycles to be used, and the number of cycles to be applied, will depend upon assessment of the worst case in-service logistics of the store and the amount of accelerated ageing to be represented. Account should be taken of any environmental protection (eg by container design) provided for the store.

c. Test Procedure The test shall be conducted in accordance with AECTP-300 - Method 303.

6. Low Free Fall Drop

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following a low free fall drop.

b. Information A study of the MTDS for the host equipment should determine the maximum height from which the test should be conducted (eg railcar, truck, VERTREP). The preferred figure is a minimum of 1.5 m. The host equipment specification should indicate whether it is required to remain safe for handling and disposal, or safe and suitable for service following the drop. (See also Safety Test No 3 in Annex D).

c. Test Procedure The test shall be conducted in accordance with AECTP-400 - Method 403.

7. Handling Free Fall (Unpackaged)

a. Reason For Test This test is conducted to demonstrate that the unpackaged gas generator will remain safe following a free fall drop during handling.

b. Information A study of the MTDS for the munition should determine the maximum height from which the test should be conducted. The minimum figure is 1 m. The test criteria should indicate whether the munition is required to remain safe for handling and disposal, or safe and suitable for service following the drop.

c. Test Procedure The test shall be conducted in accordance with AECTP-400 - Method 403.

8. Underwater Shock

a. Reason For Test These tests are conducted to demonstrate that the gas generator, when embarked in a naval or merchant vessel and subjected to the shock of underwater explosion, will not additionally hazard the vessel, and where appropriate will remain safe and suitable for service use.

b. Information There are 2 levels of severity of test. For Vessel Survival Safety the test shock levels to be applied will be such that the vessel will safely survive. The host equipment is required to remain safe for handling and disposal at this level. For Survival for Service Use, the host equipment must remain safe and suitable for service. The Survival for Service Use Test is to be conducted as part of the sequential trial. The shock level will vary according to the class of ship and the location of magazines and mountings

c. Test Procedure The tests shall be conducted in accordance with national procedures.

9. Rain

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following exposure of its host equipment to driving rain.

b. Information The parameters of the test are defined by rainfall intensity and duration.

c. Test Procedure The test shall be conducted in accordance with AECTP-300 - Method 310.

10. Salt Spray

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following exposure to a salt atmosphere.

b Information The salt solution used in the test should be representative of typical marine atmospheres. The severity of the test is determined by the spraying time and the subsequent storage conditions (temperature, humidity and duration). Apart from naval munitions, this test is normally only conducted if metallic parts are exposed to the environment.

c. Test Procedures The test shall be conducted in accordance with AECTP-300 - Method 309.

11. Contamination by Fluids

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following exposure to fluids typical of those which may cause contamination in service.

b. Information The range of fluids to be considered include fuels, oils, hydraulic fluids, solvents, cleaning fluids, battery electrolytes and nuclear fall-out decontamination fluids. The fluids to be used and the severity parameters should be determined from the MTDS. Consideration should be given to the need to pre-heat some fluids to appropriate temperatures.

c. Test Procedures The test shall be conducted in accordance with national procedures.

12. Tactical Vibration

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable during operational carriage.

b. Information The real environment is a mixture of random and sinusoidal vibration Stowage and carriage on mountings in ships has a dominant sinusoidal component at specific low frequencies, whereas random vibration may be more significant in fighting vehicles. Track patter may have specific sine vibration peaks at discrete frequencies. The vibration environment of external or internal carriage on fixed-wing aircraft is essentially random in nature. Rotorcraft will have random vibration with superimposed sinusoidal vibration at rotor frequencies. The type of vibration testing selected must be chosen from the worst cases identified from the MTDS specified in the ammunition specification. It may be necessary to carry out the selected vibration tests at appropriate high and/or low temperatures associated with specified areas for operational deployment, and to consider the effect of low air pressures associated with carriage at high altitude.

c. Test Procedure Tests shall be conducted in accordance with AECTP-400 - Method 401, using data gathered from the appropriate platforms or standard test levels if no monitored data is available.

13. Electromagnetic Radiation, Electrostatic Discharge and Lightning

a. Reason For Test This test is conducted to demonstrate that the gas generator will remain safe and serviceable following exposure to various electrical and electromagnetic environments.

b. Information Electromagnetic environments which the host equipment is expected to survive and remain serviceable thereafter include the levels of electromagnetic radiation specified in STANAGs 1307 and 4234. Other electrical environments in which the gas generator ammunition is expected to remain safe include electrostatic discharge levels specified in STANAG 4235 and lightning levels specified in STANAG 4236.

c. Test Procedures The tests shall be conducted in accordance with STANAG 4239 (with AOP-24) and national procedures until relevant STANAGs are implemented.

14. Nuclear Hardening

a. Reason For Test This test or assessment is conducted to demonstrate that the gas generator will remain safe, or safe and serviceable, following exposure to the effects of a nuclear explosion.

b. Information The potentially damaging effects of a nuclear explosion are electromagnetic pulse (EMP), nuclear radiation, air blasts and thermal radiation as defined in AEP-4. Consideration should be given to severity levels of these effects at which the gas generator should remain safe, and severity levels at which the gas generator should remain safe and serviceable.

c. Test Procedure The test or assessment shall be conducted in accordance with STANAG 4416.

15. Critical Examination

a. Reason For Test These tests are conducted to assess the effects of environmental stressing and artificial ageing on the gas generator.

b. Information The gas generator is examined to determine if any physical or chemical changes occur in the gas generator during the MTDS.

c. Test Procedures The tests shall be conducted in accordance with national procedures

RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION / PAYS	NATIONAL RATIFICATION REFERENCE / REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT / DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION/MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION / DATE ENVISAGEE DE MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED / DATE EFFECTIVE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE								
CA								
CZ								
DA*	MAM3 204.69-S4519 9902186-004 of/du 28/04/98	STANAG	06/00	06/00	06/00			
FR	Decision No. 001263 DGA/DSA of/du 15/09/99	STANAG	10/99	10/99	10/99			
GE	BDVg Fu S IV 1 – Az 03-51-60 of/du 02/07/99	STANAG						
GR								
HU								
IT								
LU								
NL	M99002294 of/du 19/04/99	STANAG				03/00	03/00	03/00
NO	MAS17/99/FO/LST/OHS/ STANAG4519 of/du 08/12/98	STANAG	01/00	01/00	01/00			
PL								
PO								
SP								
TU	TUDEL-99/STAN-1788 of/du 24/03/99 & STAN-992246 of/du 20/04/99	HAVSTANEM 807-1		12/02	09/00			
UK	D/Dstan/12/15/4519 of/du 15/02/00	STANAG	03/00	03/00	03/00			
US*	OUSD(A&T) of/du 04/12/99	STANAG	12/99	12/99	12/99			

* See overleaf reservations/Voir réserves au verso
\+ See comments overleaf/Voir commentaires au verso

RESERVATIONS/RÉSERVES

DENMARK

The Danish Army will implement the requirements of STANAG 4519 for purchases of equipment that have not previoulsy been in the Danish Army inventory and for modification of equipment initiated after implementation.

The Royal Danish Air Force will continue refurbishment of munitions in the current inventory utilising existing design criteria for gas generators

UNITED-STATES

Page E-5 paragraph 13b – The US employs stricter requirements than those specified in STANAG 4234. The US has not ratified STANAG 4234.

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DANEMARK

Les forces terrestres danoises mettront en application les critères du STANAG 4519 pour les achats de matériels qui ne figuraient pas précédemment dans son inventaire et pour les modifications de matériel entamées après la mise en application. Les forces aériennes royales du Danemark poursuivront le reconditionnement des munitions figurant actuellement dans l'inventaire en appliquant les critères nominaux existants pour les générateurs de gaz.

ETATS-UNIS

Page E-5, alinéa 13b - les Etats-Unis appliquent des critères plus stricts que ceux qui sont mentionnés dans le STANAG 4234, qu'ils n'ont pas ratifié.